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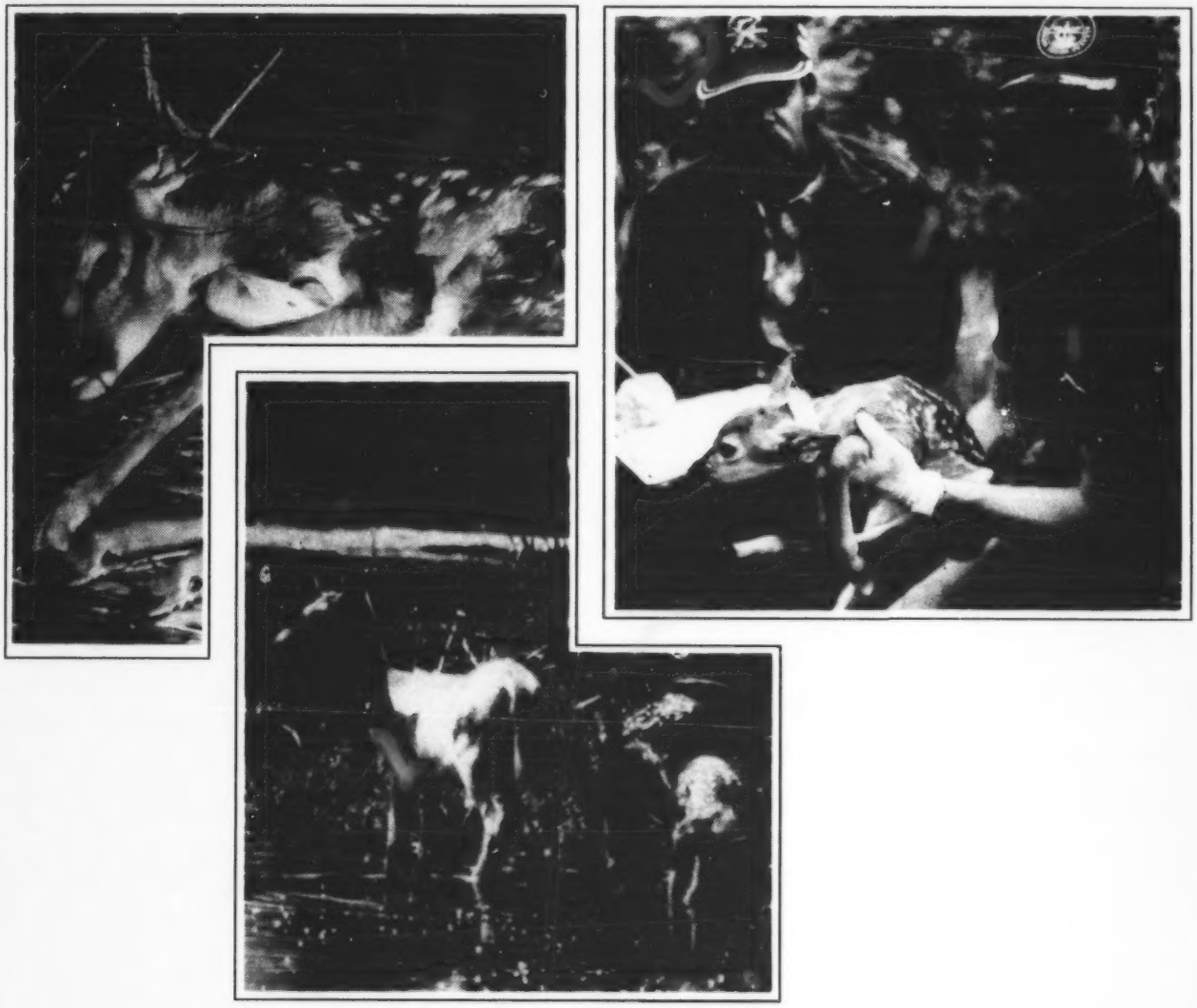
White-tailed Deer Fawn Mortality in Southeastern Saskatchewan

Wildlife Technical Report 91-1



WHITE-TAILED DEER FAWN MORTALITY

IN

SOUTHEASTERN SASKATCHEWAN

WILDLIFE TECHNICAL REPORT 91-1

by

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ABSTRACT

To investigate rate and causes of post-partum white-tailed deer fawn mortality, from birth to 5 months of age, 29 fawns, born between 1 June and 11 July 1990, were live-captured and fitted with radio transmitters (16), retrieved dead (6) or monitored (7) with 16 radio-collared and 10 uncollared does near Corning in southeastern Saskatchewan. Ten fawns died from unknown causes (3), malnutrition (3), coyote predation (2) and accidents (2). Coyotes were suspect in fawn deaths resulting from unknown causes. Mortality was highest during the first month following parturition and declined in July and August. No fawn mortality occurred in September and October. Observed summer fawn mortality was 34%. However, fetus counts from does necropsied during the winter predicted fawn production at 1.9 fawns:doe, suggesting that search crews were unsuccessful in locating all fawns at birth. Fall fawn-at-heel observations indicated that only 0.7 fawns:doe survived the summer. Accounting for unobserved production and adjusting for sampling bias, summer fawn mortality was estimated at 41 to 65%. Mortality was high compared to rates reported for many North American deer populations and exceeded previous Saskatchewan estimates. Fawns also displayed large and highly variable movement patterns, reflecting doe feeding and habitat preferences or a response to human disturbance. Home ranges increased from 21.7 ha in June to 33.3 ha in August and averaged 60.4 ha for the 8-week period following parturition. Most fawns (52%) were born or selected bedsites in grass-shrub vegetation in small aspen poplar stands. Short and tall shrub pasture and willow ringed dry wetlands were used to a lesser extent. Does moved their fawns shortly after birth, separated siblings and bedded apart from their fawns during the summer, presumably to avoid predators. More precise cause-specific estimates of fawn mortality will enhance the ability of wildlife managers to predict population growth using computer models and to implement appropriate sport harvest strategies.

ACKNOWLEDGEMENTS

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INTRODUCTION

Computer population models are used extensively by wildlife biologists as a management tool to predict ungulate population changes under different sport-hunting regimes. These models require reliable estimates of natality and mortality to simulate herd dynamics and enable managers to assess new management initiatives. The Pop-II model (Bartholow 1987) was recently used by Saskatchewan managers to predict growth of white-tailed deer (Odocoileus virginianus) populations subjected to liberalized antlerless hunting seasons (Killaby 1987), examine moose (Alces alces) population growth using predator control and restrictive sport harvest strategies (Brewster 1989), and allocate mule deer (Odocoileus hemionus) hunting licences to achieve population reductions (SPRR 1990).

These modelling exercises demonstrated a critical need for better estimates of neonatal mortality, particularly for white-tailed deer, from birth to recruitment into the fall population (Brewster 1989). Many North American studies provide estimates of white-tailed deer fawn mortality, but rates vary from 8-96% depending on geography, predators and environmental factors (Porath 1980). Most research has dealt with deer herds in semi-arid areas like Texas (Carroll and Brown 1977), treed areas in Minnesota (Schulz and Frydendall 1983), farmlands in the mid-west United States (Huegel et al. 1985a) and deer herds that have been supplementally fed or located in refuges and enclosures (Verme 1977). Only a few studies (Hall 1972, Ransom 1967) have been conducted on northern whitetail populations that are routinely subjected to extreme climatic fluctuations or reside in the aspen poplar (Populus tremuloides) habitat unique to the western Prairies.

Preliminary observations suggest that Saskatchewan white-tailed deer reproductive performance and post-partum fawn mortality may be impacted by severe winters, prolonged drought, high coyote (Canis latrans) populations and habitat conditions (Brewster 1989). The objective of this study was to quantify and determine the causes of white-tailed deer fawn mortality, from birth to 5 months of age, in the Parklands of southeastern Saskatchewan. Fawn parturition chronology, birth site selection, spatial relationships, behaviour, movement patterns and habitat preferences were also investigated to assess their impact on mortality.

STUDY AREA

The study was conducted on 1305-km² of flat, sparsely treed farmland located near Corning in southeastern Saskatchewan, approximately 160 km southeast of Regina (Fig. 1). The area, situated in the dark brown soil zone of the Moose Mountain

uplands, is comprised of cultivated farmlands (65%), treed uplands (15%), pasture lands (10%), wetlands (5%), haylands (3%) and permanent lakes (2%).

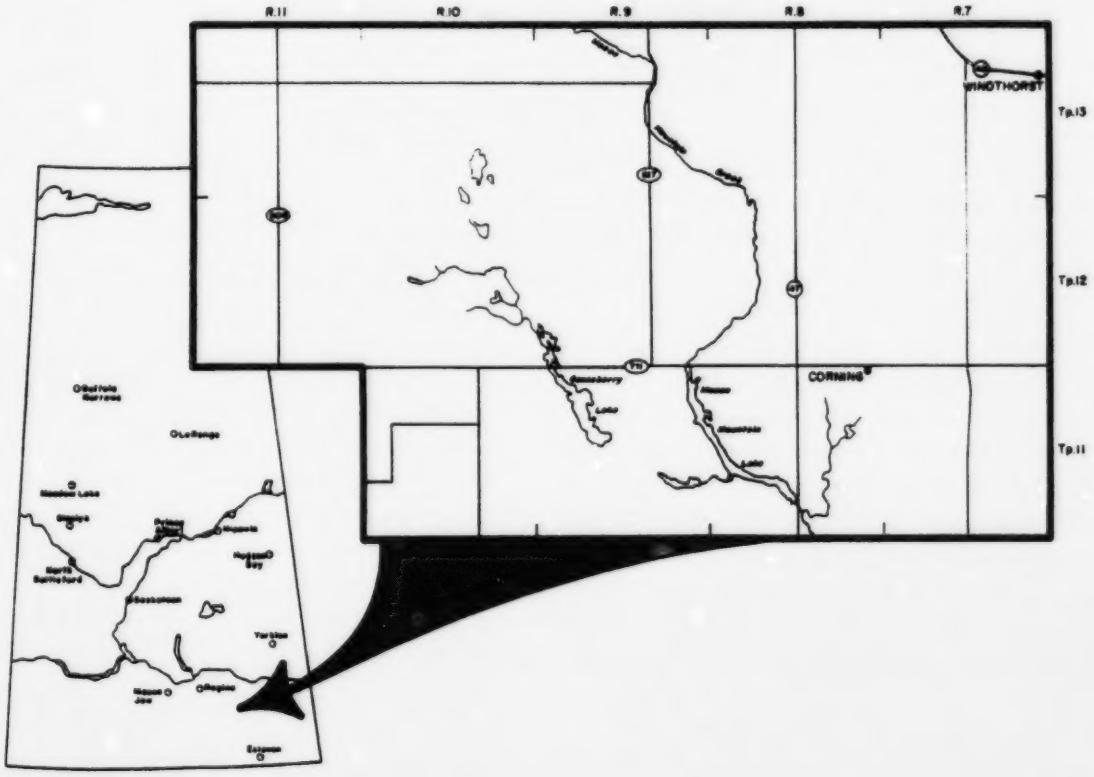

Fig. 1. Location of the Corning study area in southeastern Saskatchewan.

The cultivated lands support cereal agricultural crops including wheat, barley, canola and some hay crops of alfalfa (Medicago sativa) and introduced tame grasses. Small aspen poplar stands and willow (Salix spp.) ringed wetlands with sedges (Carex spp.) and grasses are scattered throughout the cultivated areas. Larger aspen poplar stands and complexes of snowberry (Symphoricarpos occidentalis) and rose (Rosa acicularis) dominant the pasture lands. All poplar stands support an understory of snowberry, rose, grass and sedges with some chokecherry (Prunus virginiana), alder (Alnus rugosa), saskatoon (Amelanchier alnifolia) and willow.

There are two major lakes (Moose Mountain Lake and Gooseberry Lake) in the study area. A large valley complex (Moose Mountain Creek) drains from the north into

Moose Mountain Lake. The side slopes and bottom lands adjacent to Moose Mountain Creek support small aspen poplar stands and snowberry-rose complexes. The smaller drainages have a temporary water supply and lesser amounts of woody vegetation. The remaining waterbodies are temporary or semi-permanent wetlands of various sizes, many surrounded with a perimeter of willow or aspen poplar. Most small and medium size wetlands were dry during the study.

The climate is semi-arid with extreme annual variations in both temperature and precipitation. During the study, temperatures ranged from -39.2 to 12.0 C ($\bar{x}$ = -9.8 C) from November 1989 to March 1990 and -8.7 to 37.0 C ($\bar{x}$ = 11.7 C) from April 1990 to October 1990, inclusive. Monthly snowfall and rainfall for these time periods averaged 22.2 cm (range 10.8 - 29.2 cm) and 4.6 cm (range 1.3 - 10.0 cm), respectively. The 1989-90 winter was rated moderately severe for white-tailed deer (SPRR 1990).

The area supports moderately high white-tailed deer and coyote populations. A January 1991 aerial survey reported average deer densities of 1.1 deer/km². Densities ranged from 72 deer/km² on 3 pastures with greater than 50% aspen poplar to 13 deer/km² on cultivated lands supporting 25-49% aspen poplar. Densities declined to 2 deer/km² on sparsely treed pasture lands and 1 deer/km² on cultivated areas with less than 25% aspen cover. Landowners reported that 1990 coyote densities were high relative to other years. Observations, vocalization and den counts conducted in summer 1990 and winter 1991 estimated minimum densities of 0.03 to 0.19 coyotes/km² (SPRR 1991).

METHODS

From late-January to mid-March 1990, 81 white-tailed deer, including 37 re-traps, were live-trapped at 8 sites using a modified Stephenson box trap (Runge 1972). Eighteen females, 1.5 years and older, were fitted with radio-equipped (Lotek Engineering Ltd, Aurora, Ont.) coloured neck collars. Estimates of age were derived from molar tooth impressions off plaster cast moulds.

Radio-collared does were located bi-monthly until late spring to determine movement patterns. Does were re-located daily from 24 May to 12 July to identify parturition sites and assess fawn production. Does that remained in the same location or localized area for 3 to 5 consecutive readings were judged to have given birth (Huegel et al. 1985b). The behaviour of the doe and the absence of her previous year's fawn(s) was an indication of pending parturition (Downing and McGinnes 1969). Uncollared does, encountered while travelling in the study area, were also observed for parturient behaviour or the presence of fawn(s).

A crew of 5-10 persons flushed both radio-collared and uncollared does following parturition, systematically searched the site and captured the fawns with a large hoop net. An expandable (18 cm to 35 cm) Krydex white plastic collar (Keister et al. 1988) with a 9 hr delay motion-sensitive mortality transmitter (Lotek Engineering Ltd, Aurora, Ont.) was fitted around the fawn's neck. The collar, weighing about 50 g, was designed to expand with the growing fawn and drop off in 7 to 9 months. A red metal numbered tag was inserted in the ear for additional identification. Fawn ages were determined from hoof development, standard body measurements, the degree of umbilical healing and behavioral attributes (Haugen and Speake 1958). Some fawns, only observed with a doe, were assigned the same age as siblings captured or retrieved dead at birth. Handling time from initial capture to release at the capture site averaged 13 $\pm$2.3 min and did not exceed 24 min. Capture sites were marked with red flagging tape to facilitate subsequent site data collection.

Radio-collared fawns were located twice daily (8:00 to 11:00 and 16:00 to 20:00 hrs) to 7 Aug but not disturbed to avoid influencing habitat selection, movement patterns and predator avoidance. A minimum of 2 azimuths were taken within 15 min using a 4-element yagi directional antenna mounted either on a truck or an all-terrain cycle. Adult female locations and proximity to their fawns were determined and plotted on 1:20,000 aerial photographs. Fawn home ranges were determined for 14-day intervals by the minimum convex polygon method (Mohr 1947, White and Garrott 1990). Areas (ha) were calculated with a geographic information system (Terra-soft, Nanaimo, B.C.) from UTM co-ordinates assigned to each telemetry location. Analysis of variance and Duncan's multiple range tests were used to detect differences between time periods.

Dead fawns were retrieved and necropsied on site for cause of death. Carcasses for which the cause of death could not be determined were frozen and sent to the Western College of Veterinary Medicine (Saskatoon, Sask.) for examination. Monthly cause-specific mortality rates were calculated, using the MICROMORT software program (Heisey and Fuller 1985), for fawns from both radio-collared and uncollared does for the 1 June to 31 October interval. Summer fawn mortality was derived from estimated spring fawn production minus the number of fawns observed with radio-collared does in the fall. Fetus:doe ratios obtained from Saskatchewan white-tailed deer necropsied in spring 1987 and 1988, indicated that yearling and adult does produce an average of 1.5 and 2.1 fawns:doe, respectively (Brewster 1989). These fecundity rates were assigned to radio-collared does, on the basis of age class and used to estimate spring fawn production. Fall fawn survival was derived from fawn-at-heel counts while monitoring radio-collared does from 13 July to 7 November.

RESULTS

Production

From 1 June 1990 to 7 November 1990, 29 fawns (10 males, 11 females and 8 unknown sex) were captured, retrieved dead or observed with 16 radio-collared and 10 uncollared does (Table 1; Appendix 1). Most fawns (17) were offspring of the radio-collared does; the remaining fawns (12) were from uncollared does. Fawns were born between 1 June and 11 July with peak parturition between 3-9 June (Fig. 2).

Table 1. Number of fawns captured, retrieved dead or observed with whitetail does near Corning, Saskatchewan, 1990.

	# FAWNS WITH		
FAWN ACTIVITY	RADIO-COLLARED DOES	UNCOLLARED DOES	TOTAL FAWNS
Captured	7	9	16
Retrieved Dead	3	3	6
Observed	7	-	7
TOTAL	17	12	29

Sixteen fawns (8 males, 8 females), 7 from radio-collared does and 9 from uncollared does, from 2 to 10 days old and averaging 4 $\pm$1.2 days of age, were fitted with radio-collars (Fig. 3). Another 7 fawns were observed with radio-collared does but either escaped capture or were not observed until fall. Six fawns were retrieved dead.

Most does (65%) were observed with single fawns; none were reported with triplets (Table 2). Four of the radio-collared does and 2 of the uncollared does were observed with twin fawns (23%). Only 1 of the does with twins was observed with both offspring by fall. Three radio-collared does, 2 of which were trapped as yearlings, were observed with no fawns (12%).

Spring fawn production from radio-collared does was estimated at 31 fawns (1.9 fawns:doe), 45% higher than observed (1.1 fawns:doe) by search crews. Crews reported that with vegetation in full leaf flush, fawns were difficult to locate, despite finding the doe's bedsite and conducting an intensive search of the surrounding area.

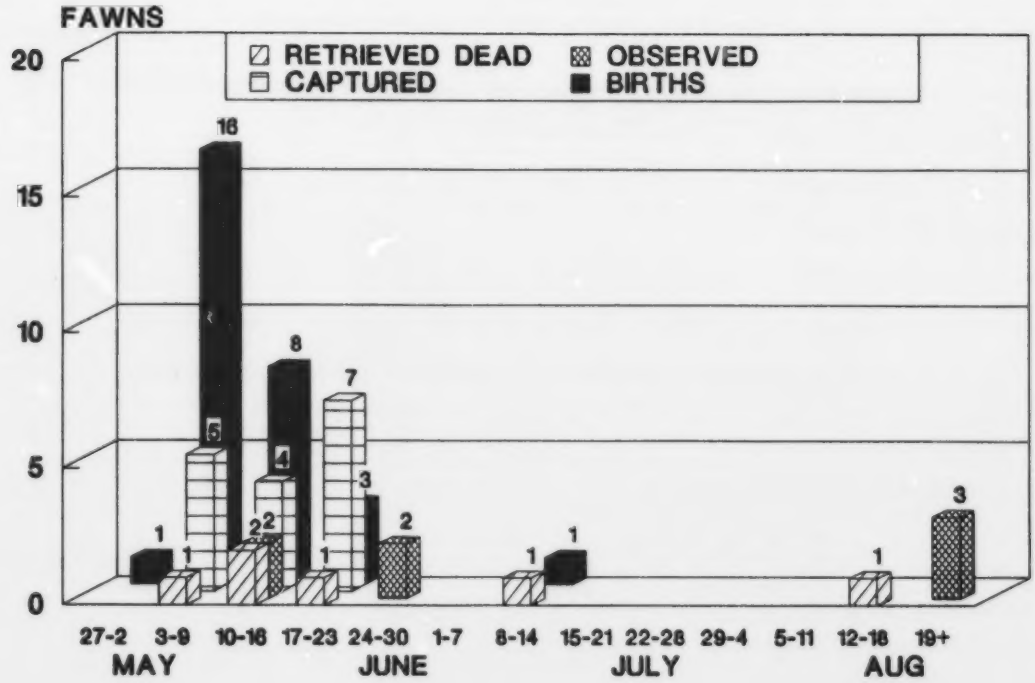

Fig. 2. Birthing chronology of fawns captured, retrieved dead or observed with whitetail does near Corning, Saskatchewan, 1990.

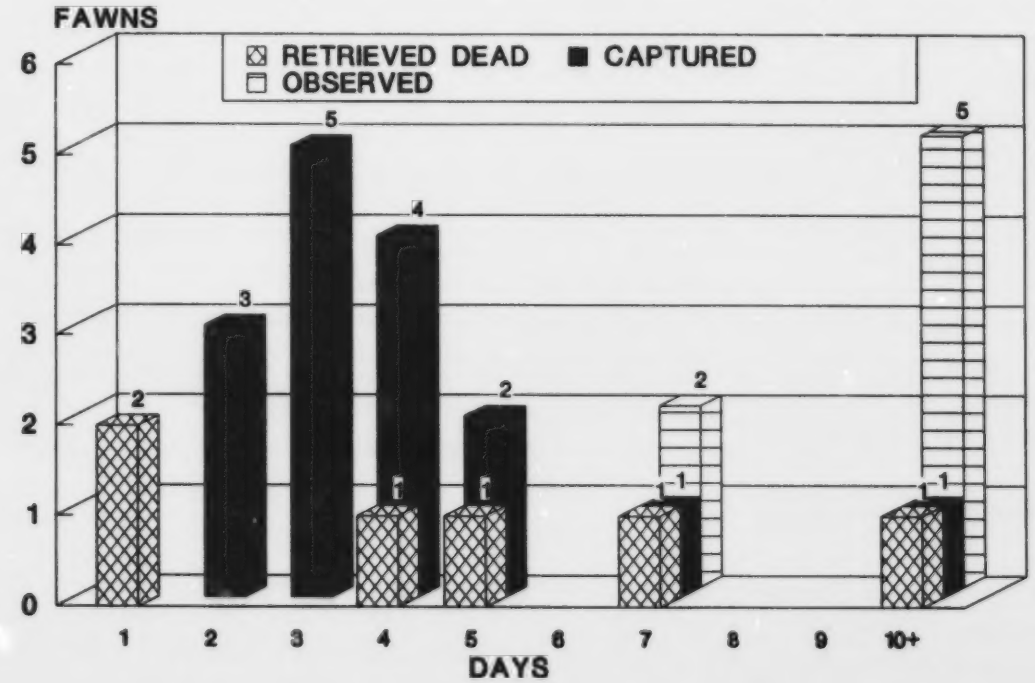

Fig. 3. Age of fawns when captured, retrieved dead or observed with whitetail does near Corning, Saskatchewan, 1990.

Table 2. Number of whitetail does observed with multiple fawns near Corning, Saskatchewan, 1990.

	# OF DOES		
FAWNS/DOE	WITH RADIO-COLLARS	WITH NO COLLARS	TOTAL DOES
0	3	-	3
1	9	8	17
2	4	2	6
TOTAL	16	10	26

Physical Condition

Eight captured fawns, less than 3 days of age, averaged 3.9 $\pm$0.3 kg in weight (range 3.3 to 4.6 kg) and appeared in good physical condition (Appendix 2). Crown-rump, body length, chest and abdominal circumference averaged 551, 626, 344 and 353 mm, respectively. Another 8 fawns, captured at 5 to 10 days of age, were heavier and larger in size and showed no evidence of starvation or nutritional stress.

Three fawns, retrieved dead at birth, averaged 2.5 $\pm$1.1 kg (range 1.7 to 3.9 kg) and weighted less ($p < 0.05$) than healthy fawns captured within 3 days after birth. These fawns were also smaller ($p < 0.05$) in body size, with average crown-rump, body length, chest and abdominal circumferences of 502, 581, 309 and 257 mm, respectively. No other skeletal differences were detected between dead and healthy fawns, retrieved or captured shortly after birth.

Two of the dead fawns were born with siblings that survived the summer. One set of twins, located 4 days after parturition, weighted 1.7 and 6.4 kg; the larger surviving sibling being similar in weight and size to healthy fawns of that age. The dead fawn from the other set of twins weighted only 1.8 kg, but because it's sibling was not observed until late summer, their physical condition at birth could not be compared.

Radio-collar Loss

All of the radio-equipped fawns lost their collars during the 8-week period between 6 June and 7 August (Fig. 4). One collar was retrieved from a fawn predated by coyotes. The remaining radio-collars were located on the ground in thick vegetation with their motion sensor activated.

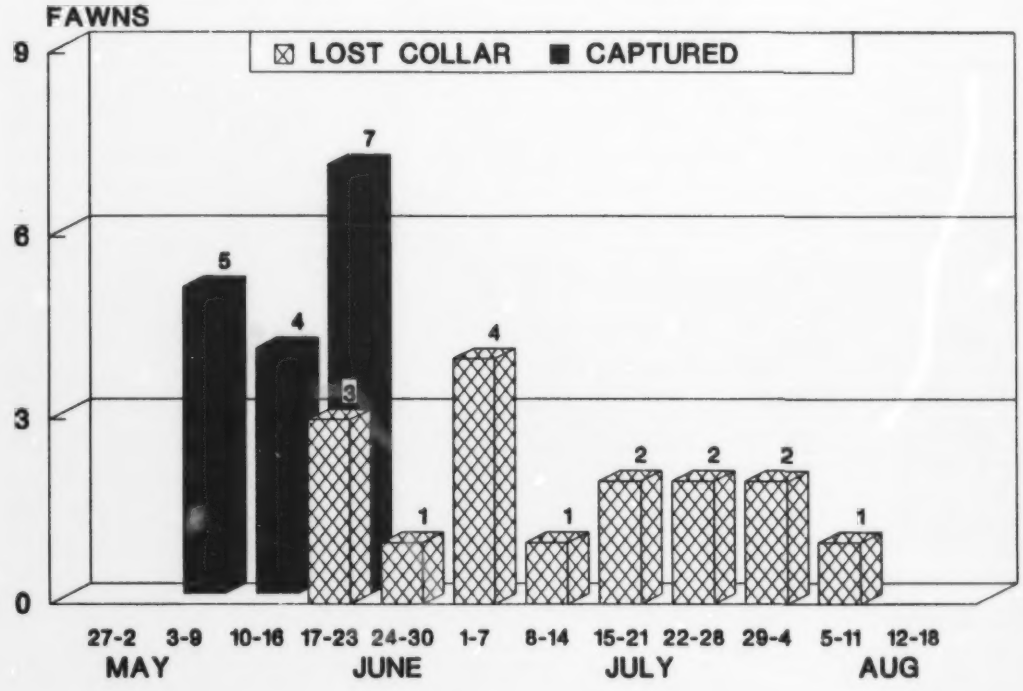

Fig. 4. Chronology of collar loss for whitetail fawns radio-collared near Corning, Saskatchewan, 1990.

Eleven collars, retrieved with the collar sprung open, appeared to have become caught on surrounding vegetation while the fawn was running and were likely pulled off the neck without injuring the fawn. Four collars, found intact, may have been slipped over the head while the fawn groomed itself with its hind feet. Tooth marks were evident on 1 collar suggesting that the doe was instrumental in collar removal.

Collar loss increased gradually, with a peak rate of loss (25%) in the third week (Fig. 5). Over half (56%) of the collars provided location and survival data for 3 weeks following parturition, the period believed critical for fawn survival.

Mortality

Between 1 June and 15 August, 6 fawns from radio-collared does and 4 fawns from uncollared does were found stillborn, predated by coyotes or dead from accident related or unknown causes (Fig. 6). Age at death ranged from 1 to 67 days and averaged 23 $\pm$14.9 days. None of the deaths appear to have been caused by capture procedures or handling-related abandonment.

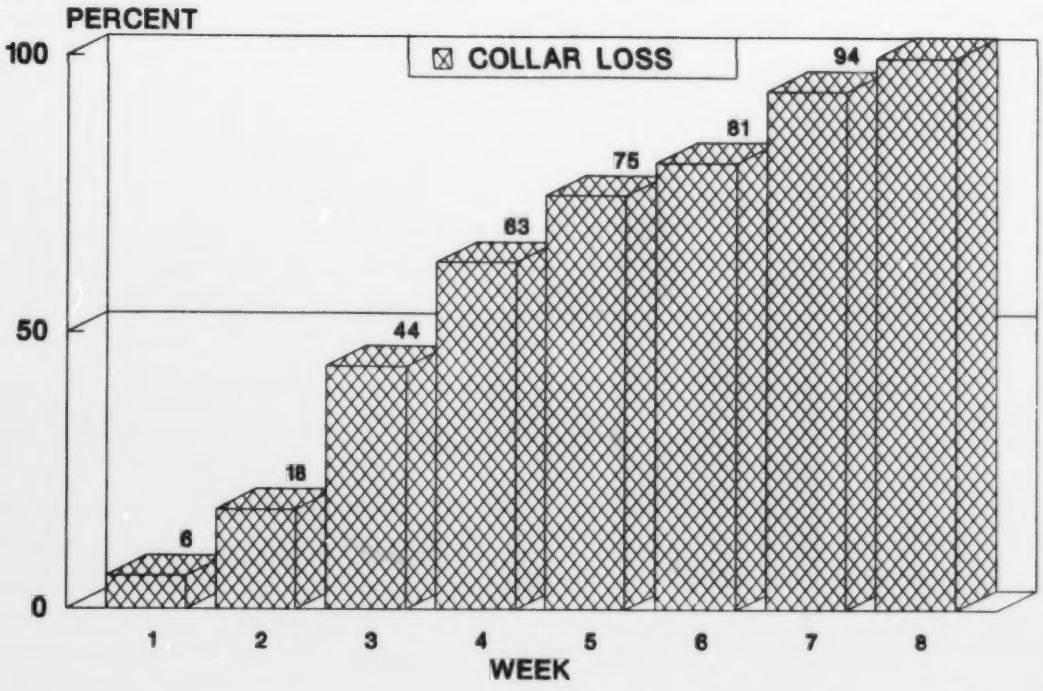

Fig. 5. Rate of collar loss for whitetail fawns radio-collared near Corning, Saskatchewan, 1990.

Evidence of coyote predation was observed in the death of 2 fawns (20%). Skull, pelvic and vertebra bone fragments from an unmarked fawn were retrieved on 6 June within 10 m of a radio-collared doe, reluctant to leave the area after being flushed by the search crew. A femur bone, pieces of hide and the collar of a second fawn were located on 1 August, 54 days after radio-collaring. Tracks at the site and canine teeth marks and hair fragments on the collar suggested coyote predation.

Three fawns (30%) died from unknown causes. One unmarked fawn, born to a radio-collared doe on June 8, was observed periodically until 30 June, after which the doe was observed alone. Another fawn, a twin of a radio-collared fawn captured on 12 June, was observed until 3 July, after which the doe and radio-collared fawn were observed alone. A third fawn, radio-collared with its twin on 21 June, lost its collar on 31 July but was not observed with the doe and its other sibling after 3 August. These fawns were judged to be in good physical condition when captured or observed with the doe.

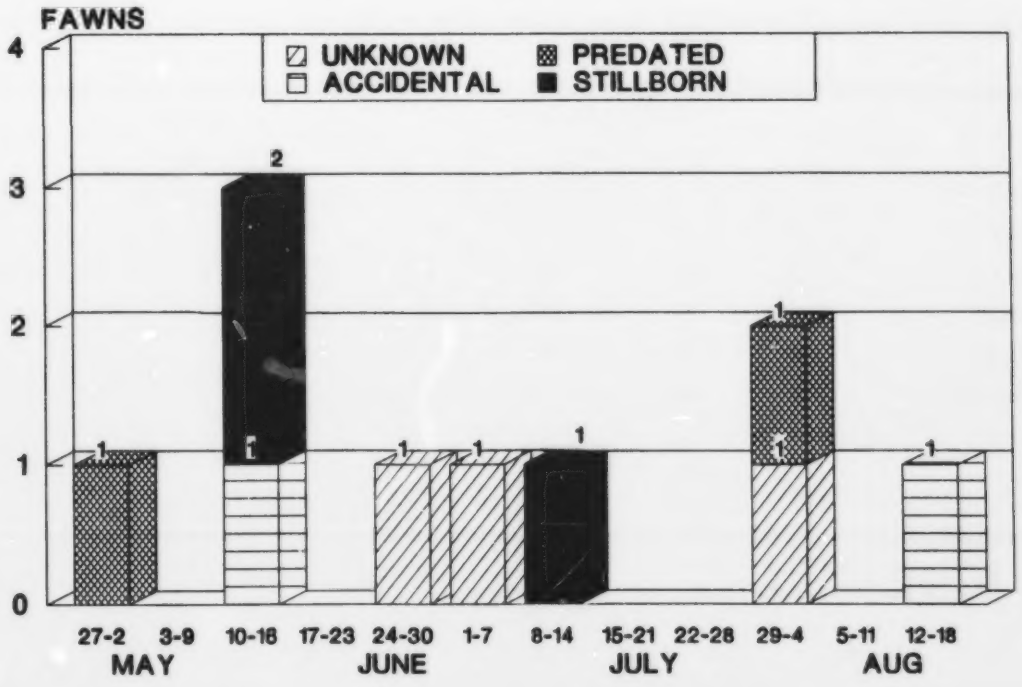

Fig. 6. Causes and chronology of whitetail fawn mortality near Corning, Saskatchewan, 1990.

Three fawns (30%) were found stillborn on 12 and 16 June and 11 July at the doe's birthing site. All of the fawns had collapsed lungs; 1 fawn showed evidence of amniotic fluid in the lungs and the other 2 fawns had not begun to breathe (Dr. H. Philibert pers comm). There was no histologic evidence of a viral or fungal infection, or vitamin A or E nutritional deficiency. Tests for leptospirosis (Leptospira interrogans) infection proved negative. The thymus appeared smaller than normal in 1 of the fawns but there were no other visible lesions. Two of the fawns were from does that produced twins.

Accidents were responsible for the death of 2 fawns (20%). One fawn died on 15 June because of a crushed skull, suggesting that it was accidentally kicked in the head by the doe while nursing. The other fawn was killed by a vehicle on 15 August while crossing a gravel road.

Observed summer fawn mortality was 34.5%. After adjustments for fawns born at different times within the same sampling period, the cause-specific summer mortality rate was estimated at 41.4% (Table 3). Mortality was highest (25.4%) in June, declined in July (8.6%) and increased slightly in August (14.1%). There was no fawn mortality observed in September and October. Stillbirths, unknown causes, coyote predation and accidents were believed responsible for the death of 13.3%, 11.5%, 8.3% and 8.3% of the fawn population, respectively.

Table 3. Cause-specific mortality and survival rates for whitetail fawns near Corning, Saskatchewan, 1990.

INTERVAL	N DAYS[1]	N RADIO[2]	% SURVIVED	% MORTALITY			
				UNKNOWN	STILLBORN	PREDATED	ACCIDENT
June	30	518	74.6	5.1	10.1	5.1	5.1
July	31	686	91.4	4.3	4.3	0	0
August	31	608	85.8	4.7	0	4.7	4.7
September	30	570	100	0	0	0	0
October	31	589	100	0	0	0	0
SUMMER RATES:			58.6	11.5	13.3	8.3	8.3
		LOWER:	41.9	-	-	-	-
		UPPER:	81.7	24.1	27.6	19.5	19.5

[1] Number of days in each monthly interval.
[2] Number of days in each monthly interval that the fawns were alive.

Fall counts indicated that only 11 fawns (0.7 fawns:radio-collared doe) of a potential 31 spring fawns survived the summer. As many as 20 fawns may have died without being observed or retrieved by search crews. The summer mortality rate was, subsequently, estimated at 41 to 65% of the spring fawn population.

Home Range Size

Fawn home ranges increased from 21.7 $\pm$18.1 ha in June to 33.3 $\pm$25.4 ha in August and averaged 60.4 $\pm$25.3 ha for the 8-week period following parturition (Table 4). Home ranges during the first 2-weeks were smaller ($p < 0.05$) than other weekly periods but significant differences between age and home range size could not be detected later in the summer. There were no differences in home range size between sexes.

Individual home ranges varied from 1.2-152.7 ha during the first 2-weeks after birth to 2.6-175 ha for the 8-week period (Table 4). One fawn, captured while moving with its doe across a grid road, moved daily and had a large home range (152.7 ha) during a 2-week period. Another fawn exhibited a large home range (125.4 ha) in week 3 and 4, but localized its activities to 49-56 ha after moving to new habitat. Several fawns moved long distances shortly after birth only to confine their movements to a small aspen poplar stand for the summer. The 2 radio-collared fawns that died during the summer displayed similar, highly variable movement patterns. One fawn moved 800 m after birth and then confined its movements to less than 7 ha; the other fawn did not move from the birthing area until week 3 only to continue movements in excess of 40 ha until death.

Table 4. Average home ranges (ha) for whitetail fawns radio-collared near Corning, Saskatchewan, 1990.

FAWN I.D.	NUMBER OF HECTARES[1] WEEK 1 & 2	WEEK 3 & 4	WEEK 5 & 6	WEEK 7 & 8	8 WEEKS
514	52.2	2.7	7.6	—	115.3
525	15.4	125.4	49.6	56.7	175.0
534	2.6	—	—	—	2.6
546	3.8	—	—	—	3.8
556	1.6	3.9	21.9	—	37.3
565	4.5	8.1	56.5	—	64.9
575	27.8	14.4	—	—	72.0
588	7.4	1.6	6.3	3.0	46.8
605	1.5	17.4	—	—	23.0
635	1.2	44.0	59.5	40.1	101.1
644	5.9	—	—	—	5.9
655	2.6	44.8	6.2	—	49.3
665	32.6	17.7	—	—	81.0
674	1.8	—	—	—	1.8
685	33.8	—	—	—	33.8
694	152.7	—	—	—	152.7
$\bar{X}$	21.7	28.0	29.6	33.3	60.4
SE	9.2	11.3	8.6	13.0	12.9
95% CI	3.6-39.8	5.9-50.1	12.7-46.6	7.9-58.7	35.0-85.7
SAMPLE SIZE (#)	16	10	7	3	16

[1] Minimum polygon home range estimate

Fawns were captured in close proximity (100 m) to their does. Within 2-24 hrs after capture, does moved their fawns (150 m to 1200 m) to new habitat. Does with twin fawns separated them shortly after birth and did not bed with either fawn. Distances between does and their offspring increased in June and by early July, some does were bedded up to 800 m from their fawns during the day. Most does were not routinely observed moving with or feeding their fawns until late summer. Yearling animals or the previous years' fawns were observed re-joining their does and her fawn(s) in early September.

Habitat Selection

The majority (52%) of fawns captured or retrieved dead were found in aspen poplar uplands, 0.5-24.0 ha in size. Tall shrub uplands, including willow ringed wetlands and abandoned farmyards were used by 22% of the fawns. The remaining

fawns were located in roadside ditches (11%), tall shrubs associated with drainages (11%) and short shrubs (4%) in pastures with moderate livestock grazing pressure. All fawns, except for those caught opportunistically while travelling with their doe, were bedded in thick grass understory vegetation.

DISCUSSION

Mortality

Comparably high fawn mortality rates have been reported from white-tailed deer range in North America but published results vary markedly. Neonatal losses, ranging from 47% (Carroll and Brown 1977) to 72% (Cook et al. 1971) were reported for semi-arid areas of Texas where coyote predation, starvation and disease were identified as primary causes. In Oklahoma, blood loss due to tick infection and coyote predation were responsible for mortality ranging from 18-64% (Logan 1972) to 88-90% (Garner et al. 1978).

Many studies in farmland and forested areas report lower fawn mortality rates. Bryan (1980) and Rice (1978) observed fawn losses of 33% and 35% in east-central Missouri and South Dakota where coyote predation and nutritional stress on the doe leading to fawn malnutrition were major sources of mortality. Mortality rates of 8%, 23%, and 15%, attributed to coyote predation, nutritional stress on the doe and starvation have been observed in mixed agricultural and forested habitats in Virginia (McGinnes and Downing 1969), a Michigan deer enclosure (Ozoga et al. 1982) and a Minnesota refuge (Schulz 1982), respectively. Huegel et al. (1985a) observed 27.2% mortality from coyotes, dogs, accidents and disease in the agricultural portion of south-central Iowa.

In more northern habitats, Ransom (1967) predicted stillbirths and postnatal losses of 20 to 50% of fawns in Manitoba following an average winter. He speculated that high post-partum fawn losses were responsible for low deer populations. Hall (1972) estimated, from winter fetus:doe and fall fawn:doe counts, 39 to 64% fawn mortality in Alberta following mild and severe winters. Lower mortality (25 to 45%), based on similar fawn:doe counts, was reported from southern Saskatchewan but thought to be under-estimated because of observer bias (Brewster 1989). Hall postulated that winter severity restricted doe nutrition, resulting in smaller fetuses and higher fawn mortality at birth. The winter preceding the Corning study was only of moderate severity, suggesting that Saskatchewan whitetails, subjected to a severe winter, may also suffer proportionally higher fawn losses.

Mortality chronology was consistent with most published results, occurring between birth and 90 days post-partum, the majority within 30 days after birth.

Mortality declined as fawns grew larger, presumably because they were better able to cope with nutritional stress and escape predators. Huegel et al. (1985a) documented coyote predation on a monthly basis up to 150 days in Iowa but late summer coyote predation was not observed during the Corning study, possibly because escape habitat was more abundant and readily available to fawns.

Causes

Most studies report coyotes as the principle source of fawn mortality (Porth 1980, Cook et al. 1971, Garner et al. 1978, Carroll and Brown 1977, Huegel et al. 1985a). During the Corning study, only 2 fawns (20%) showed evidence of predation, but coyotes may have been implicated in other fawn deaths. It is speculated that, based on their physical condition and mortality chronology, the 3 (30%) fawns that died from unknown causes may have also been predated. These fawns were healthy when observed or captured shortly after birth and died 17-43 days later when malnutrition, starvation or accidents would likely result in minimal mortality. The proportion of fawn mortality attributed to coyotes, however, was still lower than predation rates reported for many North American deer populations.

Malnutrition appeared to be a secondary cause of fawn mortality (30%). The 3 stillborn fawns were smaller than healthy fawns captured at birth and in the absence of other mortality factors, it is suspected that they died from malnutrition related causes. Verme (1977) documented similar neonatal losses in northern Michigan and like Hall (1972), postulated that nutritional stresses placed on pregnant females during severe winters resulted in mortality of malnourished fawns at birth. In the Corning area, malnutrition likely plays a more significant role following a severe winter, comprising a larger percentage of the mortality or contributing to higher overall fawn losses.

There was no evidence that increased coyote predation occurred as a result of malnutrition. Verme (1977) suggested that fawns suffering malnutrition were more susceptible to coyotes or other predators taking advantage of them in a weakened state. One fawn, partially consumed by coyotes, may have died from malnutrition related causes and then been scavenged but the condition of the fawn at birth could not be determined. Verme (1963), working on a captive white-tailed deer herd in Michigan, and Schulz and Frydendall (1983) speculated that malnutrition and starvation related mortality were not significant once fawns managed to survive the first few weeks of life. Similar results were observed at Corning, as fawns that exhibited normal weights at birth did not appear to suffer any post-partum starvation.

Fluctuations in fawn mortality have been attributed to spring vegetation density at the fawn bedsite (Smith and LeCount 1979). Wells and Lehner (1978) believed that coyotes relied primarily on visual clues to locate prey and that increased vegetation density helped to reduce a coyote's ability to locate and kill fawns. Carrol and Brown (1977) reported higher coyote predation rates in Texas than the mid-west United States (Bryan 1980, Huegel et al. 1986) because of less dense vegetation at fawn bedsites (Garner et al. 1979). The proportionally lower rate of coyote predation observed during the Corning study suggests that bedsite vegetation was abundant and of good quality relative to other areas. The aspen poplar habitats preferred by does and fawns following parturition had abundant grass understories that allowed them to hide from predators and remain comfortable on inclemently hot or cold days. These aspen bluffs are well distributed throughout the Corning area and generally not heavily grazed by cattle, preventing coyotes from searching them effectively.

Schulz and Frydendall (1983) suggested some fawn deaths may be due to a young doe's inexperience in maternal care. Predation and malnutrition related fawn losses were observed for both young and old age class does during the Corning study, including a 1.5 (predation and malnutrition), 2.5 (predation), 4.5 (predation) and 6.5 (malnutrition) year old doe, suggesting fawn mortality was not influenced by maternal age or fawning experience.

Movements and Activities

Fawn home ranges increased with age, as reported by other studies. Schulz and Frydendall (1983) demonstrated increased home range size, from 8.1-26.2 ha between May and October, in Minnnesota. Garner and Morrison (1977) reported that diurnal home ranges of fawns in Oklahoma averaged 3.3 ha at 1 week of age, 4.9 ha at 2 weeks, and increased to 52.0 ha at 12 weeks. Bryan (1980) indicated that fawns averaged 31 ha during the first 3 months after birth in Missouri.

Fawn home ranges were, however, more variable and larger in size. Most aspen poplar stands in the Corning study area were separated by large acreages of cultivated farmland and does and fawns often had to travel long distances from feeding areas to secure bedsites. These movement patterns may also reflect the doe's reliance on agricultural crops as a summer food source. The distribution of sprouting grain or flowering alfalfa and canola crops probably influenced the daily feeding patterns of does and indirectly, fawn home range size, because fawn activities and social life tend to be maternally centred (Steigers and Flinders 1980, Hirth 1977).

Human disturbance may have also influenced deer movement patterns (Gladfelter 1978). Most does moved their fawns to new habitat shortly after capture disturbance. Several fawn:doe groups periodically dispersed up to 1 km, possibly when disturbed by adjacent farming operations, returning to the same habitat 1-2 days later. Some fawns also exhibited a strong preference for a specific area or habitat, returning to these areas up to 6 times during the summer.

Fawns with large home ranges may have been more susceptible to mortality. Steigers and Flinders (1980) suggested that mule deer fawns travelling with their does increased the opportunity for coyotes to come in contact with and predate fawns. Two radio-collared fawns, believed to have been predated by coyotes, displayed larger than average (101.1-115.3 ha) home ranges (Table 4). However, home ranges were too variable and there were insufficient movement data for some time periods to produce conclusive results.

Huegel et al. (1986) indicated that whitetail fawns less than 12 weeks of age spend 80% of their time at bedsites more than 100 m from their doe, a behaviour routinely observed during the Corning study. Most does bedded away from their fawns during the day and this bedsite selection strategy appeared important in reducing the fawn's vulnerability to predators (Wells and Lehner 1978). Huegel et al. (1986) also suggested that newborn fawns selected bedsites, with cooler temperatures within the constraints of maximizing concealment from predators. The Corning fawns displayed the same preferences, usually selecting shaded bedsites in aspen poplar stands with an extensive grass understory, that were cool during the day and difficult for predators to search.

CONCLUSIONS

The Corning fawn mortality rate was high compared to many North American jurisdictions and exceeded previous Saskatchewan estimates. Coyote predation was believed to be the primary cause of fawn mortality, occurring during the first 3 months after birth when fawns are most vulnerable. This mortality may be aggravated by high coyote densities stemming from declining fur prices and lower sport and trapper harvest rates. However, reducing or eliminating coyote predation by other methods does not appear to be practical and may not impact overall mortality levels. Stout (1982) demonstrated that a reduction in the coyote population increased fawn recruitment in Oklahoma but speculated that the benefits of increased fawn survival were partially offset by higher deer mortality in other age classes. Steigers and Flinders (1980) suggested that intensive coyote control programs would eventually result in fawn mortality from other causes and higher deer populations generated by improved recruitment would sustain higher morality levels from all sources (Carroll and Brown 1977).

Malnutrition, associated with winter nutritional stress on pregnant does, also contributed to fawn mortality and may play a more significant role following a severe winter. Does, subjected to above average snow depths and wind chill indices, prolonged cold temperatures or delayed spring leaf flush will likely experience greater nutritional stress and proportionally higher fawn mortality. The high incidence of malnutrition related losses observed during the Corning study suggests that, even following a moderate winter, does are stressed to some degree. Accidental deaths due to injury and vehicle collisions occurred on an occasional basis. However, unless deer densities increase significantly, these factors will probably remain a minor source of fawn mortality.

Does implemented a variety of strategies, presumably to protect their fawns from predators, including moving the fawns shortly after birth, selecting separate bedsites and keeping their fawns hidden until mid-summer. Fawn activities and movement patterns were highly variable and influenced by the feeding preferences of their doe, human disturbance and habitat distribution. Fawns preferred well-vegetated bedsites in small aspen poplar stands that provided maximum thermal protection and hiding cover. These habitats appear to be important for fawn survival but are susceptible to agricultural development because of their relatively small size and proximity to other cultivated farmland.

More precise estimates of neonatal losses and the cause-specific factors responsible for fawn mortality contribute to our knowledge of deer population dynamics in Saskatchewan and will facilitate more informed decisions on deer management (Porth 1980). With improved computer modelling capabilities, wildlife managers will be better able to predict population changes over time and design appropriate hunting strategies.

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Appendix 1: Status of fawns captured, retrieved dead or observed with whitetail does near Corning, Saskatchewan, 1990.

DOE I.D.	DOE AGE	SPRING FAWNS1	OBSERVED FAWNS	FAWN I.D.	FAWN SEX	BIRTH DATE	CAPTURE DATE	CAPTURE AGE	RETRIEVE DATE	RETRIEVE AGE	OBSERVE DATE	OBSERVE AGE	COLLAR LOSS	COLLAR DAYS	DEATH DATE	DEATH AGE	FALL STATUS	FALL FAWNS	DAYS SURVIVED2
003	6.5	2.1	2	F2	M	JUNE12			JUNE13	1									
				F11	UNK	JUNE12									JUNE12	1	DEADBIRTH	1	1
014	4.5	2.1	1	F12	UNK	JUNE 9					OCT 31	142					ALIVE		142
023	1.5	1.5	1	F7	UNK	JUNE 9					OCT 31	145					ALIVE	1	145
033	4.5	2.1	1	F4	UNK	JUNE 8					JUNE16	7					ALIVE	1	145
043	2.5	2.1	2	685	F	JUNE 5	JUNE12	7			JUNE15	7			JUNE30	23	DEAD	0	23
				F8	UNK	JUNE 5							JUNE18	6			ALIVE	1	149
064	3.5	2.1	1	F13	UNK	JUNE 9					JUNE29	24			JULY 3	29	DEAD		29
073	5.5	2.1	0								OCT 31	145					ALIVE	1	145
083	1.5	1.5	0															0	
103	4.5	2.1	1	546	M	JUNE 5	JUNE 8	3										0	
114	1.5	1.5	0										JUNE19	11			ALIVE	1	149
123	2.5	2.1	2	635	M	JUNE 9	JUNE13	4										0	
				F9	UNK	JUNE 9							AUG 1	51	AUG 1	54	PREDATED	1	54
134	1.5	1.5	1	F6	F	JULY11			JULY12	1	JUNE26	18					ALIVE		145
143	6.5	2.1	1	565	F	JUNE10	JUNE13	3							JULY11	1	DEADBIRTH	0	1
154	4.5	2.1	1	525	F	JUNE 9	JUNE11	2					JULY15	33			ALIVE	1	144
164	1.5	1.5	1	F1	UNK	JUNE 1			JUNE 6	5			JULY28	48			ALIVE	1	145
173	2.5	2.1	2	575	F	JUNE 5	JUNE 8	3							JUNE 1	1	PREDATED	0	1
				665	M	JUNE 5	JUNE 8	3					JULY 3	25			ALIVE	2	149
													JULY 5	28			ALIVE		149
SAMPLE	16	31	17	17	9	17	7	25	3	7	7	488	7	202	6	109	17	11	1716
MEAN	3.4	1.9	1.1					3.6		2.3		69.7		28.9		18.2		.7	100.9
KIPLING	UNK	2.1	1	694	F	JUNE 3	JUNE 6	3					JUNE20	14			ALIVE	1	151
GOOSEBERR	UNK	2.1	1	674	M	JUNE 3	JUNE 8	5					JUNE24	16			ALIVE	1	151
711GRID	UNK	2.1	1	655	M	JUNE 9	JUNE19	10					JULY15	27			ALIVE	1	145
HERITAGE	UNK	2.1	2	534	M	JUNE16	JUNE20	4					JULY 5	16			ALIVE	1	138
				F5	M	JUNE16			JUNE20	4					JUNE16	1	DEADBIRTH		1
GLENAVON	UNK	2.1	1	556	M	JUNE15	JUNE20	5					JULY23	34			ALIVE	1	139
HWY47	UNK	2.1	1	605	M	JUNE16	JUNE20	4					JULY11	21			ALIVE	1	138
CHURCH	UNK	2.1	1	644	F	JUNE17	JUNE21	4					JULY 5	15			ALIVE	1	137
NEAR173	UNK	2.1	2	514	F	JUNE19	JUNE21	2					JULY31	41	AUG 3	46	DEAD	1	46
				588	F	JUNE19	JUNE21	2					AUG 7	49			ALIVE		135
NEAR003	UNK	2.1	1	F3	F	JUNE 8			JUNE15	7					JUNE15	7	INJURY	0	7
UNKDOE	UNK	2.1	1	F10	F	JUNE10			AUG 15	67					AUG 15	67	VEHICLE	0	67
SAMPLE	26	52	29	29	21	29	16	64	6	18	7	488	16	435	10	230	29	19	2971
MEAN	UNK	2.0	1.1					4.0		14.2		69.7		27.2		23.0		.7	102.4

1. Spring fawns refer to estimated production based on fetus:doe ratios in 1987-88 winter necropsy of pregnant does.
2. Days survived refer to number of days from birth to October 31, 1990.

Appendix 2: Weights (kg), measurements (mm) and handling time (min) for whitetail fawns captured or retrieved dead near Corning, Saskatchewan, 1990.

FAWN I.D.	FAWN AGE	FAWN SEX	CROWN RUMP	BODY LENGTH	HIND LEG	HIND FOOT	FRONT LEG	HEAD LENGTH	HEAD WIDTH	HEAD HEIGHT	HEAD BREADTH	EARSPAN	AURICLE	NECK CIRCUM	CHEST CIRCUM	ABDOMEN CIRCUM	BODY WEIGHT	HANDLING TIME
F1	1																	
F2	1	M	435	524	322	220	274	130	37	104	42	71	87	153	298	255	1.8	
F5	1	M	470	555	322	228	287	142	39	110	37	71	85	154	285	240	1.7	
F6	1	F	602	664	378	267	343	156	42	133	56	86	107	180	345	277	3.9	
MEAN			502	581	341	238	301	143	39	116	45	76	93	162	309	257	2.5	
588	2	F	563	606	352	258	332	163	43	130	46	81	112	168	365	340	3.4	
514	2	F	514	614	356	262	327	150	42	128	45	80	106	160	335	294	3.5	13
MEAN			539	610	354	260	330	157	43	129	46	81	109	164	350	317	3.5	13
525	3	F	612	682	370	272	347	146	50	130	50	85	110	187	330	402	4.6	11
665	3	M	450	542	343	254	323	156	51	138	42	74	87	180	350	395	3.9	9
575	3	F	530	595	335	234	302	153	49	144	48	72	90	168	345	307	3.3	8
565	3	F	610	635	373	264	330	162	45	130	36	86	108	204	342	384	4.0	11
546	3	M	568	710	360		370					85	125				4.5	20
694	3	F	566		358	252		142	55	140		75	104	165			4.3	14
MEAN			556	633	357	255	334	152	50	136	44	80	104	181	342	372	4.1	12
534	4	M	664	740	403	285	370	178	44	150	44	85	128	203	380	410	6.4	13
605	4	M	612	698	394	276	204	156	53	174	42	121	88	178	386	402	5.1	
635	4	M	647	740	415	292	366	145	53	152	58	94	106	186	417	467	6.7	
644	4	F	490	645	421	271	197	142	49	182	44	113	77	193	393	405	5.8	13
MEAN			603	706	408	281	284	155	50	165	47	103	100	190	394	421	6.0	13
556	5	M	611	714	406	283	367	172	47	142	45	87	119	193	422	450	5.8	14
674	5	M	605	642	371	275	361	162	50	144	76	87	104	186	414	395	5.8	14
MEAN			608	678	389	279	364	167	49	143	61	87	112	190	418	423	5.8	14
F3	7	F	670	770	410	303	397	170	46	143	50	101	130	212	438	452	8.0	
685	7	F	642	695	391	282	252	167	44	140	57	94	116	197	407	423	6.4	10
MEAN			656	733	401	293	325	169	45	142	54	98	123	205	423	438	7.2	10
655	10	M	699	764	467	295	377	162	51	205	55	118	115	195	424	477	8.5	24
F10	60	F	815	972	522	366	472	214	53	186	58	114	142	228	562	605	17.6	
SAMPLE MEAN			589	675	384	272	330	158	47	145	49	90	107	185	381	388	5.5	13